Microarcsecond Astrometry as a Probe of Circumstellar Structure

Thangasamy Velusamy and Slava G. Turyshev

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

ABSTRACT

The Space Interferometry Mission (SIM) is a space-based long-baseline optical interferometer for precision astrometry. This mission will open up many areas of astrophysics, via astrometry with unprecedented accuracy. Wide-angle measurements, which include annual parallax, will reach a design accuracy of 4 μas. Over a narrow field of view the relative accuracy is better, and SIM is expected to achieve an accuracy of 1 μas. In this mode, SIM will search for planetary companions to nearby stars, by detecting the astrometric `wobble' relative to a nearby (<1°) reference star. The expected proper motion accuracy is μas yr-1, corresponding to a transverse velocity of 10~μas-1 at a distance of 1~kpc.

Such an accuracy of the future SIM instrument provides a very useful astrometric tool for probing the circumstellar structure. The motion of the photo center as detected by SIM is not necessarily that of the center of mass. It is expected that unmodelled dynamics of the stellar systems may be a potential source for systematic astrometric errors. In this paper we discuss the possibility of using SIM's precision astrometry not only to detect Keplerian signatures due to the planetary motion around nearby stars, but also to characterize the structure of the planetary and proto-planetary orbits, accretions disks, debris disks, circumstellar material, jets and other types of the mass transfer mechanisms. We evaluate possible astrometric signatures due to different types of dynamical processes (both gravitational, non-gravitational) and characterize the magnitude of the corresponding astrometric signal. We attempt to address the most natural scenario of non-Keplerian motion, caused by an extended structure and complex dynamics of the stellar systems that may produce a detectable wobble in the motion of the optical center of a target star. We examine the use of (as astrometry, as complementary to high resolution imaging, to detect some of the structures present around stars.

This work was performed by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Keywords (for indexing): **interferometry, astrometry, young stellar objects (YSO)**